

After-school STEMMERS Report

2012-2013

Overview:

During the 2012-2013 academic year Aurora University, in collaboration with Communities in Schools and West and East Aurora school districts, delivered an afterschool STEM program to Jefferson, Simmons and Waldo middle school students.

Program Delivery:

Given the abbreviated nature of the program during this year it was decided the STEM program would focus on the science and mathematics of the digestive system. Twelve Aurora University students were recruited and hired to serve as group facilitators with an anticipated ratio of 1:5 university/middle school students. In February and then again in March AU facilitators attended 1.5 hours of training on the science units which were taken from the Amazing Science summer curriculum.

While it was our intention to begin delivery in February, weather cancelations prohibited us from doing so and the first week of the program was the week of March 11th. On average, between 12-15 students were in attendance at Jefferson and Simmons Middle Schools and between 15-18 students were in attendance at Waldo during the month of March. Attendance tapered off to an average of 8-10 students at Jefferson and Simmons during April but increased at Waldo where between 25-30 students were served on occasion. As expected, typically AU student facilitators had between 3-5 students with the exception of Waldo where middle school students outnumbered AU facilitators.

Collaboration with CIS and school personnel was professional and staff members were always helpful in coordinating and assisting during program delivery. At Simmons the STEM staff was often assisted by Mr. Chaney and Ms. Moran who were helpful and accommodating. Neither Waldo nor Jefferson had any extra staff support though Jesus Diaz and Barbara Swenson from CIS were always helpful.

Program delivery occurred on Tuesdays at Waldo and Jefferson and on Thursdays at Simmons. Various locations were provided for meeting including computer labs, teacher classrooms, and the library. Students, most of whom were sixth graders with a few seventh and eighth graders, were administered a pre-test and attitude survey during their initial session and then again at the conclusion of the program.

Results:

Due to unreliable attendance and program transiency, results were somewhat difficult to evaluate. As is typical, attendance waned toward the end of the session when afterschool sports and activities such as track and a school play were offered during similar time slots. Despite these complications, however, pre-post tests in science content did indicate statistically significant growth in knowledge about the digestive system. Additionally, one school indicated an improved attitude toward science and another school indicated a slight decline in attitude. The final school participants did not have the attitude survey administered at the end of the program. For the complete data and analysis report please see the addendum: Evaluation of the Digestive Unit STEM Project Delivered in the City-Wide After-School Program, Spring, 2013

Looking Ahead:

In an effort to deliver a high quality program planning has already begun for the 2013-2014 academic year. The program will again be delivered at all three schools for one hour once per week. The program will commence in October and end in April in collaboration with Communities In Schools. To improve attendance and attrition rates, we have planned for a set number of available slots accompanied by a wait list. Any student who is not able to attend for more than two sessions will forfeit their slot for students on the waiting list. Furthermore, data will be collected at each session rather than at the beginning and the end of the entire program. Once again, the STEM curriculum for Amazing Summer Science will be used as a guideline for exploring the topics of the environment, energy & flight, and health & nutrition.

Evaluation of the Digestive Unit STEM Project Delivered in the City-Wide After-School Program, Spring, 2013

An evaluation was undertaken of the Digestive System Unit delivered in the City-Wide After-School Program to benefit the youth in the program and pilot test the unit prior to its delivery in the Amazing Summer Science camp setting. A summary of the curriculum delivered is attached as Appendix A. To evaluate the impact of this intervention, two approaches were taken. First, pre-tests and post-tests of knowledge about the digestive system were created and implemented. Second, assessments of attitude toward health sciences were implemented at pre-test and post-test. This report presents a summary of research questions and significance as well as information about the sample, development/revision of the instruments used, the data collection methods, data analytic method, results, and discussion.

Research Questions

- 1) Was the program delivered associated with change in knowledge about the digestive system?
- 2) Was the program delivered associated with a change in attitude toward health sciences?

Significance

Over the past 10 years, availability of STEM jobs has grown 10 times faster than availability of non-STEM jobs (Langdon, McKittrick, Beede, Khan, & Doms, 2011). In addition, these jobs are likely to provide greater job stability than non-STEM counterparts. Finally, STEM occupations are projected to grow by 17.0% from 2008 to 2018, compared to 9.8% growth for non-STEM occupations (Langton et al., 2011). Wages for STEM workers are 26% higher than they are for non-STEM counterparts. However, U.S. students perform consistently below average or the third quartile in international comparisons of preparation in science or mathematics (President's Council of Advisors on Science and Technology, PCAST, 2010). Wide disparities in STEM achievement are evident between various ethnic groups (PCAST, 2010). Moreover, research demonstrates extremely low interest in middle school and high school students in participating in STEM careers. Thus, finding ways to attract students to the study of STEM, to retain them, and to develop the skills they need to succeed in these stable, lucrative, and available job opportunities is a critical priority. This objective promotes both the well-being of the student and his/her family and the preparedness of America to compete in the global marketplace.

Hossain and Robinson (2012) specifically identify both after-school programs and summer camps as avenues for garnering interest in the study of STEM. The current study investigates an active learning approach to engaging students in an after-school program in the study of the digestive system. The curriculum was a five week instructional sequence comprised of short discussions followed by active learning opportunities. The population was comprised of academically at-risk middle school students. Both learning and attitude change were assessed over the course of the project.

Methodology

Population

The study utilized a convenience sample of three middle schools in two midwestern, urban school districts. The students who participated in the program were enrolled in an after-school program. The after-school program is intended to serve students who are academically at-risk. The population characteristics of the schools included are reflected in Table 1.

Table 1: *Population Characteristics of Schools Selected for the Study*

	% Low Income	% Minority	% Meets or Exceeds	Status
School 1	77.2	84.3	68	Academic Watch
School 2	85.8	96.8	70	Academic Watch
School 3	86.8	94.5	62	Academic Watch

Table 1 demonstrates that the students served by the schools selected are disproportionately likely to be academically at-risk. The after-school programs in these schools serve the students with the greatest academic needs. In each school, students were able to participate in the STEM pilot on a voluntary basis. Thus, not all students were present for all curricular units. Furthermore, a certain degree of mismatch between pre-tests and post-tests was evident as a result of the voluntary nature of the participation in this program – that is, some students completed pre-tests but not post-tests, and some students completed post-tests but not pre-tests. The completion rates are reflected in Table 2.

Table 2: *Pre-test and Post-test Completion by School*

	Pre-tests Knowledge	Post-test Knowledge	Knowledge matches	Pre-test Attitude	Post-test Attitude	Attitude matches
School 1	15	8	6	15	6	4
School 2	18	6	6	16	0	0
School 3	20	33	10	18	28	7
Total	53	49	22	48	35	11

As demonstrated in Table 2, additional students joined the program as it went along in some cases. However, not all students completed the post-test attitude survey, and in some schools the attitude survey was not implemented in the second round of testing. Moreover, the post-test that was designed, which included qualitative questions about what students liked best/least about the program and what they would recommend changing, was not used – rather, the pre-test was used at both pre-test and post-test. Thus, only quantitative results are reported here.

Instrument

The instrument was developed in two parts. The first part was a criterion-referenced test of knowledge about the digestive system. This test was derived directly from the curriculum and was developed, reviewed, and revised by both the professional educators managing delivery of the curriculum and the program evaluator. The test was scored based on a key provided by the professional educators.

The attitude test was derived by adapting and combining two existing instruments. The first was the Science Opinion Survey, also referred to as SOS (Gibson & Chase, 2002). The second was the Modified Attitudes Toward Science Inventory, also referred to as MATSI (Weinburgh & Steele, 2000). The Science Opinion Survey is an assessment consisting of 30, 5-point scale items. The initial study was normed on grades 7-8, and subsequent studies included grades 6-8. The domains evaluated were engagement and attitude.

The MATSI survey consists of 25, 5 point scale items. The survey was normed on 5th grade students. The instrument was revised by the original author in order to increase reliability for urban, African-American 5th grade students and reduce administration time.

The final attitude survey utilized for the present study was called the Health Science Opinion Survey. All questions were phrased in a positive direction, and the phrasing was adapted such that questions pertained to "health science" rather than to "science." A total of 6 questions were derived from the MATSI, 7 were derived from the SOS, and two were created as an extension of questions present in these surveys (the two new statements were, "I would like to do research about health when I grow up" and "Learning about health science is important because it helps you to be healthy"). The reliability and validity of the resultant survey are unknown; however, the Health Opinion Survey has strong face and content validity based on extensive review. The survey is attached as Appendix B.

Data Collection, Rights of Human Subjects

The data collection process was done via paper and pencil at the first class session and the last class session. The parents of the youth in the after-school program has previously given written consent for their children to be involved in evaluation activities, including surveys and interviews, to assess impact of the after-school program activities. Thus, additional consent was not necessary. The assent form used had also been previously approved, as it was used in the evaluation of the Amazing Summer Science program in summer of 2012. This assent form was read to youth prior to their participating in the surveys, and it was made completely clear that youth could elect not to participate or could discontinue participation with no loss of right or benefit to which they would otherwise have been entitled. Contact information for questions about the study and about rights as a research participant was provided. Information about the fact that the evaluation constituted research as well as risks (none known), benefits (helping learn how knowledge and attitude changed), and use of data was provided.

Data Analysis

All data were entered into SPSS. Averages for pre-tests and post-tests were calculated. A paired samples t-test was conducted to evaluate differences in the means for the pre-tests and the post-tests for knowledge. A total of 22 matched tests were available for this analysis. However, only 11 matched tests were available for the analysis of differences in mean attitude between pre-tests and post-tests. This was because many youth joined the project late and did not have pre-tests, some of the youth who took pre-tests left the program early and did not take post-tests, post-tests of attitude were not used in all sites, and not all youth responded to the post-test attitude questions. A paired samples t-test was also conducted for the mean attitude scores at pre-test and post-test

Results

The averages for all pre-tests and post-tests of knowledge are represented in Figure 1.

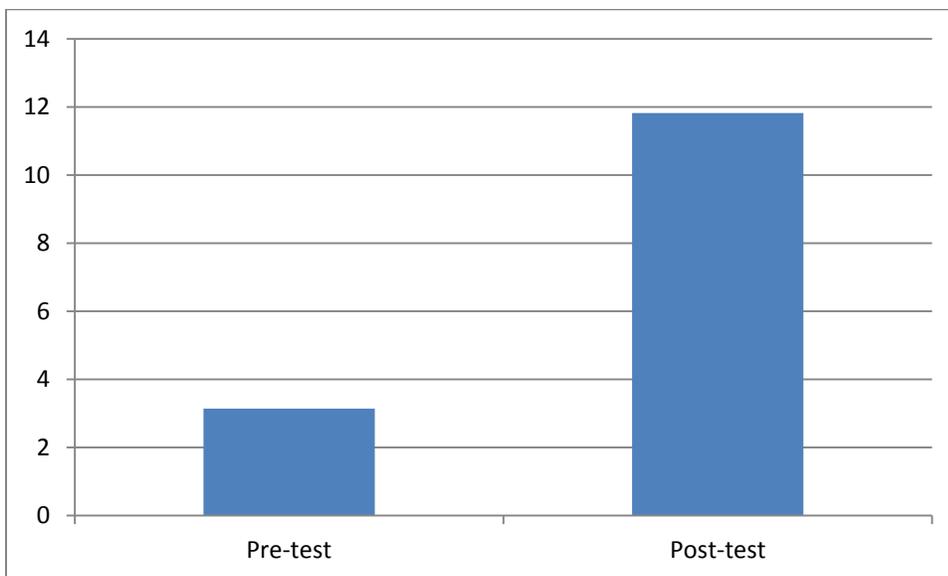


Figure 1: Averages for pre-tests and post-tests of knowledge

The difference between the average pre-test scores and post-test scores is statistically significant ($t(21) = -10.62, p = .000$, pre-test mean was 3.14 and post-test mean was 11.82). The average score on the attitude scale remained virtually the same over the course of the study period (43.5 at pre-test and 43.1 at post-test). No significant differences were measured for attitude. However, the standard deviation for this variable increased from 7.22 at pre-test to 12.46 at post-test. This suggests that the program improved the attitudes of some youth, but for other youth, a worsening of attitude was measured. Determining why some youth experienced positive change in this regard while other youth did not may prove a fruitful avenue for future investigation.

Discussion

The findings of the study suggest several things. First, the programs experienced significant instability in attendance. In the first two programs, approximately half the youth who were present at the pre-test were not present at the post-test. In the third program, again approximately half of the youth discontinued attendance, but they were offset by a large number of youth (approximately 20) who began attending part way through the program. While this dynamic may relate to the time of year in which the post-tests were measured (April, a notable time for instability in attendance), the possibility that youth chose not to continue with their attendance at the STEM program remains. Further examination of why youth initiated participation in this program but discontinued attendance is warranted.

Despite the difficulties with attrition and matriculation, a significant change in knowledge concerning the aspects of the digestive system addressed in the program was measured. This suggests that even a very brief program (as little as five weeks) delivered using experiential learning methods can affect knowledge about specifically identified STEM topics. This finding holds promise for future implementation of this and similar programs.

The reasons why the attitude change measured was not significant are unknown. Program attendance was variable with many youth having attended portions of the program but not the entire program. The inability to measure youth attitudes at two points in time for a substantial proportion of the youth involved in the program was a detriment to its evaluation, as were the fact that the attitude test was not delivered consistently at the time of the post-test and the fact that no qualitative data were gathered. However, given that the improvement in knowledge measured was significant, any robust change in attitude should have been evident. The failure to measure change suggests several possibilities. First, the possibility that experiential learning in health sciences does not change attitude about health sciences must be considered. Second, the possibility that the instrument utilized is not a reliable and valid measure of attitude toward health sciences must be considered. Given that no instruments measuring attitude toward health sciences were found, utilizing a constructed instrument was a reasonable approach. However, further study to establish reliability and validity of instrumentation is warranted. Given that a somewhat higher degree of variation than expected was observed, some of the items included in the instrument may be targeted for modification or exclusion in subsequent use. A third possibility is that the program as associated with positive attitude change for some students but not for others. Close examination of attitude change (using all available data, not only matched tests) demonstrates that attitude increased by approximately 8 points for one school, while it decreased by approximately 3 points for a second school. This suggests the program was not experienced in a consistent way by students across all program settings. This hypothesis cannot be examined statistically due to the small size of the data set. Further examination of differences in implementation across program settings are recommended if the program is delivered in diverse program settings in the future.

References

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